

Application No. 09/816,983
Amendment dated June 15, 2004
Reply to Office action of April 19, 2004

Amendments to the Claims:

This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

1 Claim 1 (cancelled):

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1 Claim 2 (cancelled):

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1 Claim 3 (cancelled):

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1 Claim 4 (cancelled):

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1 Claim 5 (cancelled):

2
1 Claim 6 (cancelled):

2
1 Claim 7 (original): A method for adaptively quantizing the encoding of a
2 video frame, said method comprising the steps of:

- 3 (a) selecting a first default QP value, a second higher QP value higher
4 than said first default QP value, and a third lower QP value lower
5 than said first default QP value;
6 (b) predicting a baseline number of bits to encode said video frame
7 using said first default QP value;
8 (c) classifying portions of said video frame into busy sectors and flat
9 sectors;

- 10 (d) predicting whether said video frame has sufficient busy sectors to
11 produce surplus bits over said baseline number of bits if said busy
12 sectors are encoded using said second higher QP value;
13 (e) predicting whether said surplus bits are sufficient to encode said flat
14 sectors using said third lower QP value;
15 (f) quantifying said busy sectors using said second higher QP value
16 and said flat sectors using said third lower QP value if said video
17 frame has said sufficient busy sectors and said surplus bits are
18 sufficient to encode said flat sectors; and
19 (g) encoding said video frame entirely using said first default QP value
20 if encoding said video frame entirely using said first default QP
21 value would be more efficient than quantifying said busy sectors
22 using said second higher QP value and quantifying said flat sectors
23 using said third lower QP value.

24
1 Claim 8 (original): The method of claim 7 further comprising the step of
2 repeating steps (a)-(g) for each of a plurality of video frames.

3
1 Claim 9 (original): The method of claim 7, wherein said step of encoding
2 said video frame entirely using said first default QP value is more efficient than said step
3 of quantifying said busy sectors using said second higher QP value and said step of
4 quantifying said flat sectors using said third lower QP value if said video frame does not
5 have said sufficient busy sectors.

1 Claim 10 (original): The method of claim 7, wherein said step of encoding
2 said video frame entirely using said first default QP value is more efficient than said step
3 of quantifying said busy sectors using said second higher QP value and said step of
4 quantifying said flat sectors using said third lower QP value if said surplus bits are
5 insufficient in number to encode said flat sectors.

6
1 Claim 11 (original): The method of claim 7, wherein said step of predicting
2 whether a video frame has sufficient busy sectors further comprises the step of setting a
3 criterion that said video frame does have sufficient busy sectors if a predicted number of
4 bits that would be required to encode all said flat sectors of said video frame using said
5 third lower QP value is less than or equal to a predicted number of said surplus bits that
6 would be provided by encoding all said busy sectors of said video frame using said
7 second higher QP value.

8
1 Claim 12 (original): A method for adaptive quantization of video encoding
2 based on prediction of required bits, said method comprising the steps of:

- 3 (a) providing a video frame;
4 (b) establishing a uniform QP value for said video frame;
5 (c) classifying said video frame into busy sectors, normal sectors, and
6 flat sectors;
7 (d) decreasing quantization below said uniform QP value in said flat
8 sectors of said video frame that can be encoded with a predicted
9 relatively small increase in said required bits needed to encode said
10 flat sectors using a QP value below said uniform QP value;
11 (e) increasing quantization above said uniform QP value in said busy
12 sectors of said video frame only when a predicted decrease in said
13 required bits needed to encode said busy sectors using a QP value
14 above said uniform QP value is relatively large; and

15 (f) reverting to said uniform QP value for all sectors of said video
16 frame if a predicted number of said required bits for encoding all
17 said flat sectors in said video frame using said QP value below said
18 uniform QP value would be greater than a predicted number of
19 surplus bits provided by encoding all said busy sectors in said video
20 frame using said QP value above said uniform QP value.

21
1 Claim 13 (original): The method of claim 12 further comprising the step of
2 repeating steps (a)-(f) for each of a plurality of video frames.
3

1 Claim 14 (original): The method of claim 12, said step of classifying said
2 video frame into busy sectors, normal sectors, and flat sectors further comprising the
3 step of classifying visual textures using high, medium, and low texture categories and a
4 predicted required bits value for at least a portion of each sector in said video frame.
5

1 Claim 15 (original): The method of claim 12 further comprising the step of
2 summing an energy value for at least a portion of each sector in said video frame.
3

1 Claim 16 (original): The method of claim 14, said step of classifying visual
2 textures further comprising a step selected from the group of steps consisting of:
3 (a) calculating said energy value for said at least a portion of each
4 sector using at least one variance value;
5 (b) calculating said energy value for said at least a portion of each
6 sector using at least one luminance value; and
7 (c) calculating said energy value for said at least a portion of each
8 sector using at least one activity value.
9

1 Claim 17 (original): The method of claim 14, said step of classifying visual
2 textures further comprising the step of calculating a predicted required bits value for
3 each sector using a prediction error energy value.

4
1 Claim 18 (original): The method of claim 12 further comprising the step of
2 decreasing said QP by a first constant.

3
1 Claim 19 (original): The method of claim 12 further comprising the step of
2 increasing said QP by a second constant.

1 Claim 20 (cancelled):

2
1 Claim 21 (currently amended): The method of claim [[20]] 23, said steps
2 of decreasing a QP and increasing a QP further comprising the step of increasing and
3 decreasing a QP by a constant.

4
1 Claim 22 (currently amended): ~~The method of claim 21 further comprising~~
2 ~~a step selected from the group of steps consisting of:~~ A method for adaptive
3 quantization of the encoding of a video frame based on predicted bit rate, said method
4 comprising the steps of:

- 5 (a) decreasing a QP by a constant in low-textured sectors of said video
6 frame that can be encoded with a relatively small increase in said
7 predicted bit rate;
8 (b) increasing a QP by a constant in high-textured sectors of said video
9 frame only when a decrease in said predicted bit rate is relatively
10 large;
11 (c) turning off said steps of decreasing a QP and increasing a QP if
12 said relatively small increase in said predicted bit rate for encoding

13 said low-textured sectors is larger than said decrease in said
14 predicted bit rate for encoding said high-textured sectors;
15 (d) [[(a)]]selecting a constant of approximately 2.0 for linear
16 quantization; and
17 (e) [[(b)]]selecting a constant of approximately 1.5 for nonlinear
18 quantization.

19
1 Claim 23 (currently amended): ~~The method of claim 20, further~~
2 comprising the steps of: A method for adaptive quantization of the encoding of a video
3 frame based on predicted bit rate, said method comprising the steps of:

4 (a) decreasing a QP in low-textured sectors of said video frame that
5 can be encoded with a relatively small increase in said predicted bit
6 rate;
7 (b) increasing a QP in high-textured sectors of said video frame only
8 when a decrease in said predicted bit rate is relatively large;
9 (c) turning off said steps of decreasing a QP and increasing a QP if
10 said relatively small increase in said predicted bit rate for encoding
11 said low-textured sectors is larger than said decrease in said
12 predicted bit rate for encoding said high-textured sectors;
13 (d) [[(a)]]providing a complete digital representation of at least one
14 video frame encoded by said adaptive quantization to a decoder;
15 and
16 (e) [[(b)]]displaying said at least one video frame on a display device
17 in a decoded form.

1 **Claim 24 (original): A method for determining the rate of data**
2 **compression for digital storage of a sequence of video frames, said method comprising**
3 **the steps of:**

- 4 (a) **dividing said sequence of video frames into individual video frames;**
- 5 (b) **establishing a usual rate of data compression for each video frame;**
- 6 (c) **dividing each video frame into sectors;**
- 7 (d) **predicting a bit rate cost for digitally storing each sector;**
- 8 (e) **predicting a visual complexity for each sector;**
- 9 (f) **dividing said usual rate of data compression by a first constant for**
10 **each sector in which said predicted visual complexity is low and**
11 **said predicted bit rate cost for digitally storing is low;**
- 12 (g) **multiplying said usual rate of data compression by a second**
13 **constant for each sector in which said visual complexity is high and**
14 **said predicted bit rate cost for digitally storing is high;**
- 15 (h) **maintaining said usual rate of data compression at a nearly**
16 **constant value for all sectors in said video frame if an absolute**
17 **value of a predicted increase in an overall bit rate cost for digital**
18 **storage of all sectors in which said predicted visual complexity is**
19 **low and said predicted bit rate cost for digitally storing is low is**
20 **greater than an absolute value of a predicted decrease in an overall**
21 **bit rate cost for digital storage of all sectors in which said predicted**
22 **visual complexity is high and said predicted bit rate cost for digitally**
23 **storing is high; and**
- 24 (i) **encoding each sector of each video frame in said sequence of**
25 **video frames to obtain a complete digital representation of said**
26 **sequence of video frames.**

27

1 Claim 25 (original): The method of claim 24 further comprising the steps
2 of:

- 3 (a) providing said complete digital representation of said sequence of
4 video frames to a decoder; and
5 (b) displaying said sequence of video frames on a display device in a
6 decoded form.

7
1 Claim 26 (original): The method of claim 24, wherein said step of
2 predicting a bit rate cost for digitally storing each sector further comprises the steps of
3 calculating said bit rate cost by:

- 4 (a) determining an energy parameter for each sector;
5 (b) determining a quantization step size value for each sector;
6 (c) defining each sector having the square root of a value of said
7 energy parameter less than said quantization step size value
8 divided by a third constant as having a low bit rate cost for digital
9 storage; and
10 (d) defining each sector having the square root of a value of said
11 energy parameter greater than said quantization step size value
12 multiplied by a fourth constant as having a high bit rate cost for
13 digital storage

14
1 Claim 27 (original): The method of claim 24, said step of predicting a
2 visual complexity for each sector further comprising the steps of calculating said visual
3 complexity by:

- 4 (a) determining an activity parameter for each sector;
5 (b) determining first and second threshold activity values for
6 categorizing said visual complexity of each sector;

- 7 (c) defining each sector having a value of said activity parameter less
8 than or equal to said first threshold activity value as having low
9 visual complexity;
10 (d) defining each sector having a value of said activity parameter both
11 greater than said first threshold activity value and less than or equal
12 to said second threshold activity value as having normal visual
13 complexity; and
14 (e) defining each sector having a value of said activity parameter
15 greater than said second threshold activity value as having high
16 visual complexity.

17
1 Claim 28 (original): The method of claim 24, said step of predicting a
2 visual complexity for each sector further comprising the steps of calculating said visual
3 complexity by:

- 4 (a) determining a maximum activity parameter for each sector;
5 (b) determining a minimum activity parameter for each sector;
6 (c) determining first and second threshold activity values for
7 categorizing said visual complexity of each sector;
8 (d) defining each sector having a value of said maximum activity
9 parameter less than or equal to said first threshold activity value as
10 having low visual complexity;
11 (e) defining each sector having a value of said maximum activity
12 parameter greater than said first threshold activity value and a
13 value of said minimum activity parameter less than or equal to said
14 second threshold activity value as having normal visual complexity;
15 and
16 (f) defining each sector having a value of said minimum activity
17 parameter greater than said second threshold activity value as
18 having high visual complexity.

19

1 Claim 29 (original): The method of claim 24, said step of maintaining said
2 usual rate of data compression further comprising the step of calculating said increase
3 in overall bit rate cost by summing said bit rate costs for each sector in which said
4 predicted visual complexity is low and said predicted bit rate cost for digitally storing is
5 low.

6

1 Claim 30 (original): The method of claim 24, said step of maintaining said
2 usual rate of data compression further comprising the step of calculating said decrease
3 in overall bit rate cost by summing said bit rate costs for each sector in which said
4 predicted visual complexity is high and said predicted bit rate cost for digitally storing is
5 high.

6

1 Claim 31 (original): The method of claim 24, said steps of dividing said
2 usual rate of data compression by a first constant and multiplying said usual rate of data
3 compression by a second constant further comprising the step of executing linear
4 quantization.

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1 Claim 32 (original): The method of claim 24, said steps of dividing said
2 usual rate of data compression by a first constant and multiplying said usual rate of data
3 compression by a second constant further comprising the step of executing nonlinear
4 quantization.

5

1 Claim 33 (original): The method of claim 24, said step of maintaining said
2 usual rate of data compression further comprising the step of filtering values of a ratio
3 formed between said sectors with low visual complexity and said sectors with high
4 visual complexity for each video frame so that said sequence of video frames will
5 maintain said usual rate of data compression despite isolated fluctuations in said ratio
6 for individual video frames.

- 7
- 1 Claim 34 (original): An encoder for coding a digital picture in a video
- 2 frame, comprising:
- 3 (a) a frame divider for dividing said video frame into sectors;
- 4 (b) a bit rate predictor for predicting a bit rate cost for digitally storing
- 5 each sector;
- 6 (c) a visual complexity predictor for predicting a visual complexity for
- 7 each sector;
- 8 (d) a quantization divider for dividing a usual rate of data compression
- 9 by a first constant for each sector in which said predicted visual
- 10 complexity is low and said predicted bit rate cost for digitally storing
- 11 is low;
- 12 (e) a quantization multiplier for multiplying said usual rate of data
- 13 compression by a second constant for each sector in which said
- 14 visual complexity is high and said predicted bit rate cost for digitally
- 15 storing is high; and
- 16 (f) a quantization equalizer for maintaining said usual rate of data
- 17 compression at a nearly constant value for all sectors in said video
- 18 frame if an absolute value of a predicted increase in an overall bit
- 19 rate cost for digitally storing all sectors in which said predicted
- 20 visual complexity is low and said predicted bit rate cost for digitally
- 21 storing is low is greater than an absolute value of a predicted
- 22 decrease in an overall bit rate cost for digitally storing all sectors in
- 23 which said predicted visual complexity is high and said predicted bit
- 24 rate cost for digitally storing is high.
- 25